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Towards a Public Sector GIS Evaluation Methodology

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Abstract

There is a growing use of Geographic Information Systems (GIS) within the public sector in different countries. Geographic Information Systems require a sizeable investment in terms of financial, information and communication technology (ICT) and human resources while they are largely financed by public funds. This adoption is partly influenced by the promises of GIS that has been widely discussed in GIS literature. Geographic information systems have potential in aiding decision making and in public policy formulation and implementation. From a public sector point of view, the society should benefit from the implementation and adoption of GIS. In order to determine whether systems are meeting their intended objectives, it is of importance to develop a mechanism for measuring the success derived from implementing such systems. Evaluation is a means to justify these information systems that are being adopted. However, evaluation methodologies for public sector GIS are largely lacking. Most evaluation procedures available in literature such as returns on investment are based on the commercial sector where operations are profit driven. The public sector presents a different dimension as focus in provision of public goods with an intent to achieve societal good. This study develops an evaluation model for Geographical Information Systems within the public sector. The study is based on field data collected in various public sector organisations in Uganda. This model is not a solution to evaluation but can be used as a base to perform evaluation depending on the available variables since evaluation is context dependent. This study presents a benefit oriented approach to GIS Evaluation.

1. Introduction

Farbey *et al.* (1999:190) define IT evaluation as *"A process, or group of parallel processes, which take place at different points in time or continuously, for searching and for making explicit, quantitatively or qualitatively, all the impacts of an IT project and the programme and strategy of which it is a part."* This is achieved through the use of some criteria against some set standards and or benchmarks. Evaluation provides information for communicating to a variety of stakeholders about the progress or lack of progress of a project (Frechtling-Westat, 2002). Through this information generated from the evaluation exercise, the worth of projects can be determined. Remenyi *et al*. (1997) view evaluation as an important activity in ensuring information systems success.

The purpose of evaluation is not only to determine the success of the implemented technology, in the case of this study, the GIS, but also the lack of success. In reality, systems and technology often do not always serve their intended users and neither do they always meet their implementation

goals. This study attempts to device a model for determining the success and failures of geographic information systems. The feedback from the evaluation gives the possibility of change and improvement to current GIS implementations.

2. Research Problem

There have been numerous researches on the benefits that can accrue from GIS including (Gillespie 1994; Tulloch and Epstein 2002). This has been referred to as the impact of GIS in a study by (Nedovic-Budic 1998; Nedovic-Budic 1999). This impact can be determined through evaluation. Uncertainty as to whether GIS and related technologies are delivering their promises to society still prevails according to (Nedovic-Budic 1998; Nedovic-Budic 1999; Georgiadou and Stoter 2008). At the same time, there is need for performance measurement in order to determine the impact of GIS technology and where it is directed.

Several literary efforts has been made in describing approaches to evaluation with the information systems and GIS domains as depicted in table 4 However, most research has failed to provide concrete methods for evaluation and have been inconclusive on the applicability of the approaches in the real world. This study attempts to bridge this gap between the theoretical perspectives to evaluation from a literature point of view and the development of practical solutions that can be used in the public sector. This study attempts to develop a model for Geographical Information Systems evaluation. This study borrows concepts from information systems and e-government evaluation to develop a method that can be used as a basis for evaluating geographical information systems within public sector organisations.

3. Methodology

This study utilises the case study research methodology detailed in (Yin 1988; Yin 2003; Kumar 2000) to collect both primary and secondary data on how public sector organisations are evaluating their various spatial information systems. The research includes the problems encountered in carrying out the evaluation activity as well as possible solutions. Concepts from the various evaluation criteria are then integrated with methods and other important variables from literature in order to come up with an evaluation methodology. This study utilizes field data collected by (Kurwakumire, 2009) for evaluating GIS impact in the context of the public sector of Uganda. This case study has been revisited in (Kurwakumire, 2013). Organisations (see Table 1) surveyed where in Kampala and Entebbe.

The case study approach was utilised because of the need to investigate a contemporary phenomenon in the context of Uganda. The phenomenon under investigation is GIS which is viewed as both an information system and as a technology. The aspects of importance to the study include (1) motivations for GIS implementations, (2) levels of GIS adoption, (3) evaluation mechanisms, (4) benefits accruing, if any, from GIS use and (5) pros and cons from GIS use. The instruments used are questionnaires, interviews, observations, photographs and a focus group

discussion. The first three tools are recommended by (Yin 1988; Yin 2003) as suitable for the case study approach which is used as the basis for data collection in this research.

Table 1. Relevant Social Groups

Uganda Bureau of Statistics (Parent Organisation)	Directorate of Water Resources Management
Department of Surveys and Mapping	Ministry of Health
Northern Uganda Data Centre	UMEME
Ministry of Local Government	Petroleum Exploration
National Forestry Authority	Geological Surveys
Department of Physical Planning	Fells Consultants
Geo-Information Communication	Ministry of Education Planning
Makerere University	World Food Programme
Kampala City Council	**Wetlands Department*
Ministry of Education – UNESCO	**Uganda Wildlife Authority*
FAO Nile	**National Environment Management Authority*
Electoral Commission of Uganda	

Note: *(*) means visited but no data collected.*

3.1 Case Description

The Geographical Information Systems industry is still young as per the fieldwork per the fieldwork performed in 2008 and 2013 in the public sector of Uganda. However, several levels of implementation can be identified ranging from desktop systems to web based systems. Paper maps are used or are printed on demand for the purposes of outdoor work though use of digital data is growing. In most cases, both the manual cataloguing systems and the GIS system are being run parallel, for example at Uganda Bureau of Statistics and Surveys and Mapping Department.

Currently there is a land information system project for capturing all land parcels and connecting them to the deeds information in Uganda. A detailed presentation of the Uganda LIS was presented at the 2nd Advanced in Geomatics Research conference in Uganda by (Mono, 2013) in August 2013.

The most common use of GIS is digitizing paper maps, mapping and displaying information. Evidence of such rudimentary and intermediate use is given by (Karatunga, 2002) and (Muhwezi, 2005) in their study on the status of Spatial Data Infrastructures in Uganda. Northern Uganda Data Centre (NUDC) has been training government officials at district level from Northern Uganda in GIS and basic mapping so that they can implement their programs at department, district and ministerial level. National Forestry Authority and Geo-Information Communications (GIC) are also involved in GIS trainings for public sector agencies in a notion to improve awareness. GIC also hosts ESRI user workshops can give their feedback and difficulties they are facing in using GIS and related products. With these trainings GIS awareness is high. GIS use has evolved from mostly basic mapping to advanced web mapping and geo-processing functions according to discussion

carried out on the Advances in Geomatics Research Conference held at Makerere University in August 2013. This is evidenced in (Muhwezi, 2005) and (ori-Okido, 2005).

In local government there is an e-government initiative of connecting districts in which the LoGICS system provides a one stop shop for information on local governments. LoGICS is the local government information and communication system hosted by Ministry of Local Government (MoLG) in Kampala. On the other hand there is a current initiative in which districts in rural areas are being connected with telephone infrastructure. To further improve on the LoGICS system, the GIS component needs to be integrated in it so that it becomes a spatially enabled communications system (Oforo-Amoah, 2008). In this regard there is Uganda is taking long strides in adopting ICT in public offices.

3.2 Assumptions

There are several factors in the development and adoption of GIS in organisations which have been made to remain constant for the purposes of this study.

It is impossible for GISs implemented in different settings to be completely similar due to several factors including (1) implementation objectives, (2) organisational cultures, (3) organisational institutions and (4) end user requirements. This study generalised GIS implementations across the public sector in Uganda basing on the fact that, one of the common mandates of the surveyed organisations is to serve the public through effective public policy formulation and implementation. GISs vary in terms of their stage of development as depicted in figure 1 and in their levels of adoption within the different contexts. Different organisations present different contexts but the public sector within one setting can be generalised to resemble one context. As a result, the core operational mandates were considered to achieve this generalisation.

4. Findings

37% of the organisations are evaluating geographical information systems in their organisations while 63% are not. Organisations which are evaluating are using:

1. Typical project evaluation involving a work plan, budget, carrying out activities, making a report, comparing work planned with work carried out.
2. Consultants who are hired to evaluate: Consultants are organisations or firms that are external to the public sector agency in question who are hired to perform the evaluation. The approach of having consultants performing the evaluation is a possible method of minimising personal biases that can result from employees of the organisation performing the evaluation. However uncertainty remains on the possibility of public sector agencies hiring consultants to perform evaluation.
3. Stakeholder needs assessment followed by updating the system as per the recommendations by the end users (stakeholders)
4. Client follow-up to assess how the client is utilising information gained from trainings

5. Client follow up is carried out to assess knowledge application or practical use of knowledge from trainings. This is a method which comprises measurement of intangible benefits of knowledge transference and diffusion.
6. Use of a visitors' book and suggestion box to capture opinions from customers. The organisation then makes adjustments basing on the opinions from the users.

The instruments being used for evaluation include questionnaire surveys, interviews and stakeholder meetings. These instruments are used to collect views from users of GIS technology which form the basis of the evaluation. Availability of service facilities, number of trainings in GIS and feedback from customers form part of the criteria used. There are no standard criteria for evaluation in the public sector of Uganda, thus methods differ from organisation to organisation. Table 2 shows the methods being used for evaluation.

Table 2. Type of Evaluation Methods

Method	**Percentage Using Method**
Formal (Well documented methods)	50%
Informal (Undocumented less structured methods)	40%
Public Sector Methods (government guidelines)	10%

Formal methods refer to well documented methods in terms of criteria and guidelines. They can be specific to the GIS sector or they can be developed within an organisation. Informal methods refer to ad hoc methods which may not follow specific guidelines but still serve the purpose of evaluation. They may not have proper documentation. Public sector methods refer to government guidelines for evaluating GIS which are well documented and recommended for the public sector.

Another issue of concern is "who is involved in the evaluation." The "what is being evaluated" in this case is service delivery resulting from use of geographic information systems and or related technologies. Who to involve in the evaluation refers to social actors who are part of the evaluation team and these can be individuals, groups or organisations. Table 3 shows the actors who perform the evaluation according to fieldwork findings.

Table 3. Who performs the Evaluation?

Social Actor	**Percentage of Respondents**
GIS Operators/IT Staff	70%
Policy Makers	10%
Key Stakeholders	20%
Service Delivery Staff	20%

Fieldwork findings show a greater proportion, 63%, of respondents who are not evaluating. It is however, worthwhile to identify the reasons for not evaluating. Some of the reasons obtained from fieldwork findings for this lack of evaluation are:

1. Evaluation is still a new concept
   Public sector organisations may not be worried about evaluation since UBOS carries out the national service delivery survey in the public sector in Uganda every 4 years. Also, there are organisations that perform monitoring and evaluation through the National Integrated Monitoring and Evaluation Strategy (NIMES) framework. However, the general evaluation concepts remain the same, that is, there is need for a method, indicators and some decision making criteria. Organisations could actually borrow concepts from the service delivery evaluation to GIS evaluation.
2. Lack of facilitation
3. Organisational priorities with no allocation for evaluation.
4. Evaluation has not been thought about/ Evaluation is not a priority
   There is often reluctance for self evaluation as mentioned in some interviews and informal discussions. The public sector provides public goods which have characteristics such as *"non excludability"* and *"non rivalry."* This means that there is no competition in their production and the public goods must be accessible to all citizens, for example, the public information collected by UBOS. Thus when there are no competing firms, the driver to perform evaluation ends up lacking.
5. The absence of standards that can be used as a benchmark
6. The absence of guidelines
7. Some GISs have not been fully established
   If some GISs have not been fully established it is expected to have some formative evaluations taking place to guide the implementation. Formative evaluations are carried out before system implementation up to the later stages of the system development life cycle. The absence of these formative evaluations may even mean that GISs are being implemented without any form of cost-benefit analysis. As a result, there may be no future need to evaluate a system in future when its implementation was not justified economically on its inception.
8. Financial constraints
9. Time constraints

However these organisations are judging the success of their systems by:

1. Considering the increase in production through use of GIS
2. The number of inquiries handled
3. Efficiency
4. Appreciation by the customer is considered as positive feedback
5. The ability to be timely in what an organisation wants to achieve

4. Theoretical Views of Technology

Several theoretical perspectives have been used in information systems evaluation research. These include Interpretative approach, Grounded, Social and Accounting Theory (Berghout and Remenyi, 2005). However, for the purposes of this research, social interactionism is discussed as it has a bearing on the way society views, adopts and accepts a new technology. GIS in the context of this study are viewed as both information systems and a technology. A technological view to GIS aids in describing nature and composition of the artefact under evaluation.

4.1 Social interactionism

Campbell (1996: 32) considers the view of technology as a socially constructed reality, suggesting that innovations are not value neutral but that the introduction of technology can be loaded with social and political meaning. The view of technology as a social construct implies that the technology "is a function of the societal conditions under which it was created [and] technologies not only are rooted in society but have social consequences", (Sheppard, 1995: 7). "The social-constructivist perspective presents technology as an integral part of society and its processes of social reproduction", (Harvey and Chrisman, 1998: 1683).

Within this social constructivist perspective, the developmental process of technology is viewed as a social process (Pinch and Bijker, 1987). To understand the technology, it is important to identify relevant social groups or social actors who interact with the technology. The relevant social groups are actors who either use the technology or have an interest in the technology or are affected by the use of the technology. However, it is also necessary to include groups external to the technology that may also have relevant opinions on the technology. The social groups are the organisations stated in table 1. Within the organisations, users of the GIS technology were identified as they were the most relevant to understanding the implementation, use and adoption of the technology.

5. Related Work

This section reviews models that have been used in e-government and spatial data infrastructure (SDI) development. The intent is to gather concepts and similarities that can be adopted in achieving two objectives which are part of this study namely (1) Designing a model for GIS Development and (2) development of a GIS evaluation model.

Within the SDI domain, van Loenen and van Rij (2008) view spatial data infrastructures as having four development levels of the namely standalone, exchange, intermediary and network.

There are several models that simulate e-government development including those presented in (Gartner Research, 2003; Layne and Lee, 2001; United Nations, 2001). These models can be used to simulate the development of geographic information systems within organisations. The development includes acceptance, adoption and expansion to cover other organisations which is diffusion of the technology.

Gartner Research (2003) bases e-government development on four phases namely *presence*, *interaction*, *transaction* and *transformation*. In this model, electronic government develops from the provision of a simple website that is passive in the *presence* phase. As the technology gains acceptance, there is *interaction* between citizens, business with government through the website thus G2C and G2B. Government to government (G2G) interactions are also possible. In the transaction stage, the website is active and so are the users. Citizens, business, and other government departments are able to access and procure basic services online. In the last phase of transformation, the whole structure of government evolves to suit the needs of the modernised citizen.

Layne and Lee (2001) present a four stage e-government model based on four phases namely catalogue, transaction, vertical integration and horizontal integration. In the catalogue stage, government wants to migrate from a manual to a digital form of governance which allows users to seek and access basic information such as city housing application forms online. In the transaction stage, citizens can actually perform transactions with government such as completing and submitting the application forms on line. In vertical integration, the decentralised entities of government are connected into one network so that citizens can access services from all levels of government. The last stage is horizontal integration in which there is provision of one stop shops for various government services to citizens, business and other government departments.

Table 4. Summary of Evaluation Approaches

Source	**Themes Discussed**	**Evaluation Approaches**
Georgiadou and Stoter (2008)	SDI Evaluation	*Pure type* – control and exploratory evaluation *Mixed type* – sense-making and learning evaluation
Nedovic-Budic (1999)	What should be measured? Direct/Indirect measurements? Should contextual factors take precedence?	
Nedovic-Budic (1998)	Lack of contextual factors in GIS evaluation	Qualitative research in measuring impact of GIS
Georgiadou et al., (2006)	SDI Evaluation	Control, learning, sense-making and exploratory evaluation
Clapp et al., (1989)	Multipurpose Land Information Systems Evaluation	A means-end hierarchy to evaluation which is constituted by Operational Efficiency, Operational Effectiveness, Program Effectiveness and contributions to well-being.
Gillespie (1994)	Determining the benefits of GIS use and shortcomings of the cost benefit analysis Tangible and intangible GIS benefits The difficulties in measuring intangible benefits	Cost Benefit Analysis

Tulloch and Epstein (2002) identify efficiency, effectiveness and equity as the benefits (see Table 5) accruing from use of geographical and or land information systems (GIS/LIS). These

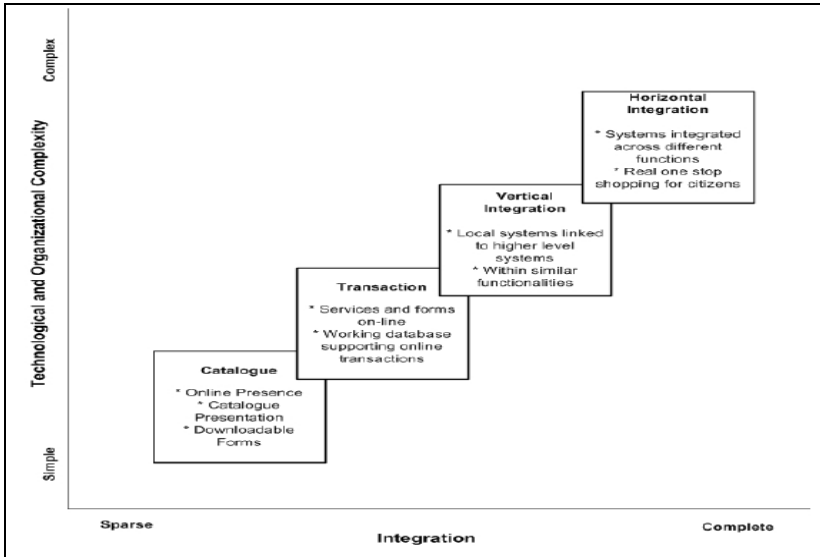
efficiency, effectiveness, and equity benefits are translated to recordkeeping, analysis and democratization respectively though they accrue at different developmental stages of the information systems. Record keeping is achieved after digital databases have been implemented such that there is efficient access to records. When the organisation can perform analytic functions with the information in the databases then effectiveness is achieved according to (Tulloch and Epstein 2002). The last stage of the benefits is equity in which democratisation is achieved though citizen empowerment derived from access to information.

These efficiency and effectiveness benefits are crucial to service delivery in the public sector as they are also the pre-requisites for achieving the equity benefits stated by (Tulloch and Epstein 2002). This equity level, though it may be difficult to realise reflects a situation in which government can reach all communities through equitable service delivery and uplifting of disadvantaged communities. However, Tulloch and Epstein (2002) argue that government are more concerned with how the system will serve the agency rather than on products which can be realised by the broader community.

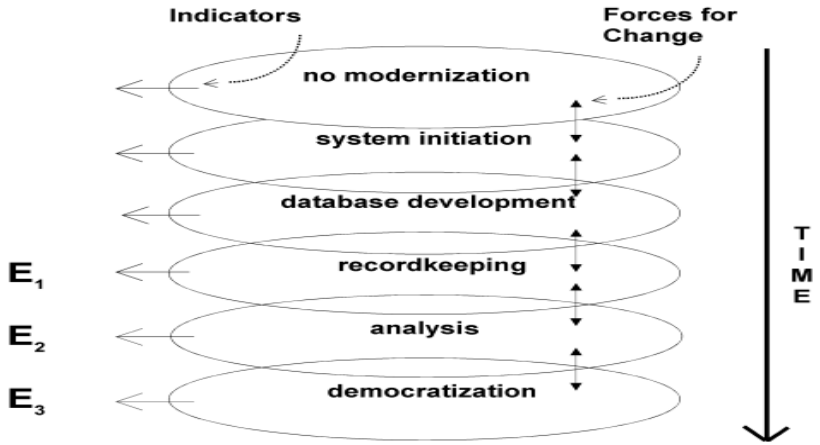
Gorgiadou and Stoter (2008) propose pure type and mixed type of evaluation approaches from four orientations to evaluation presented by (Serafeimidis, 2001). These are control evaluation, evaluation as learning, evaluation as sense making and exploratory evaluation. The pure type comprises control and exploratory evaluation while the mixed type is made up of sense-making and learning evaluation. The authors find control evaluation to be the most common within SDI evaluation efforts by public managers. Control evaluation assumes positive effects from Geo-ICT use (Geogiadou and Stoter, 2008) which reflects a technological deterministic approach presented by (Campbell, 1996). With sense-making and learning evaluation on the other hand, uncertainty is high with regard to relationship between inputs and outputs or cause and effect.

Nedovic-Budic (1999) extends the information systems success model by (Delone and Mclean, 1992) to evaluating the effects of GIS technology where she adds societal impact as a category or measure of success. She relates questions with respect to what should be measured, whether the measurements should be direct or indirect and whether contextual or technological factors should take precedence, to be important in understanding the effects of GIS use. These issues overlap with six aspects described by (Serafeimidis, 2001) who decomposes information systems evaluation to comprise of the purpose, subject, criteria, time frame, people and methodologies of the evaluation. This is further supported by (Smithson and Tsiavos, 2004: 209) who argue that what constitutes the system being evaluated may not be totally clear as system may include software, hardware, network, data and the people. These aspects are crucial to focusing the evaluation by drawing the system boundaries while making the evaluation more complete.

Table 5. Development Models



Layne and Lee (2001)



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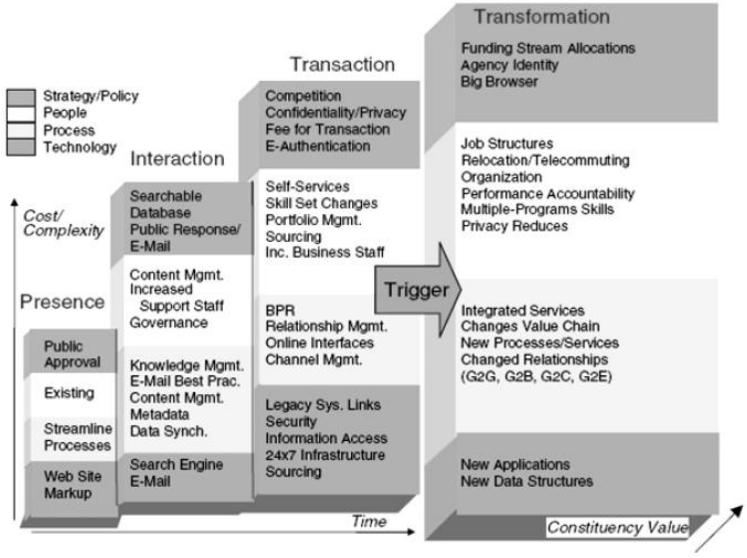


Gartner Research (2003)

		Uncertainty as to cause and effect	
		Low	High
Uncertainty as to objectives	**Low**	*Evaluation as control* Answer machine Goal monitoring Evaluator as auditor e.g., ROI	*Evaluation as learning* Learning machine Experiment Evaluator as knowledge creator e.g., CBA
	High	*Evaluation as sense making* Dialogue machine Consensus building Evaluator as facilitator e.g., simulation, prototyping, etc.	*Exploratory evaluation* Idea machine Exploration Evaluator as catalyst e.g., Value analysis

Georgiadou etal., (2006)

6. The Levels of Development of GIS

This study considers 4 levels of GIS development namely grass-root, intermediate, mature and integrated systems. The *grass-root level* is characterised by uncoordinated GIS mapping projects. Use of map data is basically for preparing fieldwork schedules and reconnaissance surveys. The geographical information systems in this case are within the first two years of implementation. The systems are basically at infancy level of the GIS development process. The major focus at this stage is still in capacity building which is achieved through introducing more equipment and personnel. The main focus is either in data collection or in digitizing available paper maps. Framework or base data in form of topographical map sheets is part of the major data that is collected. Access to information is through physical office visits to the organisations producing the information.

In *intermediate systems*, the value of GIS is slowly being realised. The human resource base is also expanding through GIS trainings such that GIS knowledge is increasing. The mapping shifts from framework data to mapping to support the data needs of particular organisations. As a result, the use of GIS and map data shifts to supporting some decision making in organisations. The data created is specific to the application areas required by the organisations. The access channels evolve to have basic information and services published on websites as data is now being produced digitally.

Mature systems portray a situation where there is orientation to service provision. GIS is viewed as a strategic entity to the success of the organisation in fulfilling its mandates. The role of GIS in decision making is well recognised. More effort is on making information available. This is the step towards democratization of data. Sectors such as health and education want to collaborate in collecting data relevant to their sectors. Information requests and access can be done through websites.

Integrated systems are the final level of development. The GIS are crossing beyond organisational boundaries. Public sector agencies are connected through communications networks into a corporate GIS infrastructure. Access to data is now possible through information portals connecting a range of stakeholders in the GIS industry. There is also a diversity of GI services available on the market. Standards and policies for sharing and accessing data are becoming more concrete at this stage.

7. A Benefit Oriented Evaluation Method

This section designs a new evaluation strategy taking the problems caused by informal methods into account. Informal methods result in a wide array of evaluation criteria across organisations and this does not provide solid ground for comparing evaluation results from different cases. These include the sampling of organisations and the use of evaluation as a feedback mechanism to future evaluations. This study develops a method basing on characteristics of the e-government development model by (Layne and Lee, 2001) and GIS/LIS benefit model by (Tulloch and Epstein, 2002). The emphasis in this design is on what to how evaluate.

The problems identified in evaluation in Uganda included: Lack of guidelines, No documentation for evaluation methods, Lack of formal approaches and the fact that evaluation is a complex activity (Kurwakumire 2009, 2013). As a result, a formal approach to GIS evaluation which is simple and easy to use is proposed as part of the results of this study. This is in the light of the claim that formal evaluations are complex and require professional expertise and at times external consultants. The new evaluation method concentrates on the measurement of intangible benefits in particular which are difficult to quantify according to both GIS and information systems literature (Obermeyer, 1999). Benefits are useful for evaluating GIS impact as they reflect the value being derived from use of GIS in organisations. Intangible benefits are particularly interesting since there are claims in GIS literature that they form the greater proportion of the benefits when compared to the tangible ones. As a result, a method to measure intangible benefits is a breakthrough in GIS literature. Intangible benefits are often neglected due to difficulties in estimating them.

7.1 Assumptions underlying the new method

The following set of concepts from the models by (Tulloch and Epstein, 2002), (Gartner Research, 2003) and (Layne and Lee, 2001) are adopted in the development of a GIS evaluation model:

MPLIS Model (Tulloch and Epstein, 2002)

- GIS/LIS benefits accrue with time
- Benefits are related to the stage of development of the GIS/LIS

E-Government development model (Layne and Lee, 2001)

- E-government has stages of development showing structural transformations of government
- The different stages of development are associated with different levels of complexity

Based on the above concepts from (Tulloch and Epstein, 2002; Layne and Lee, 2001), the following set of assumptions is used in developing a new method for evaluation:

[1] Geographical Information Systems develop following a linear four stage process

In this respect, GIS develops from grass-root, intermediate, mature to integrated systems. Four stages of growth are employed to show the development of the GIS within and outside the organisational boundaries. The first three stages show growth to maturity within individual organisations and in the last stage, integrated systems, the GISs are crossing organisational boundaries. However, the developmental process is not truly linear as there exist some factors that affect the developmental process, as suggested in (Tulloch and Epstein, 2002). These factors are institutional arrangements, GIS policies, ICT policies, technical, human and financial capacity and data sharing arrangements that exist between organisations.

[2] GIS benefits accrue following a linear pattern against time

Benefits follow a linear development with time as they accrue. GIS benefits accrue depending on the stage of development of the GIS. As a result, a particular benefit can manifest itself in different forms at different stages of GIS development. The benefits evolve from simple to mature as the GIS develop with time. However benefit accrual is affected by the organisational change process in the migration from the manual mapping and cataloguing system to an ICT enabled one.

7.2 The benefit development process

This section discusses the benefits that accrue due to GIS implementation and adoption.

Information communication

This benefit exhibits the following stages of development:

[1] Mapping to support the data needs of the organisations
[2] Use of maps for planning data collection exercises
[3] Addition of map data in reporting
[4] Addition and use of map data in policy presentations

Improved availability of data

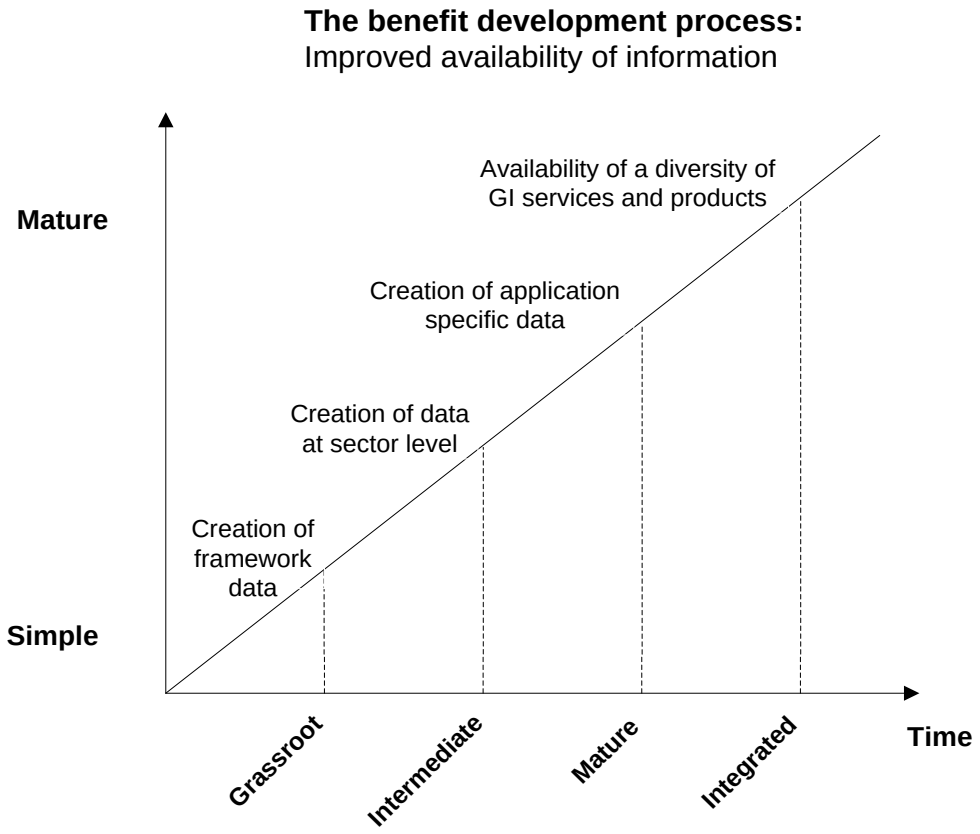
This benefit exhibits the following stages of development:

[1] Creation of framework data
[2] Creation of data at sector level
[3] Creation of application specific data
[4] The availability of a diversity of GI products and services on the market

Improved access to data

This benefit exhibits the following stages of development:

[1] Access of information through interoffice visits with paper and CD Rom media used
[2] Publishing of services through websites
[3] Requests and access of information and other services through websites
[4] Access to information through electronic portals



In the graph the benefit of *improved availability of information* changes in the different stages of GIS growth. It first manifests as framework data, which changes to sector specific data as different sectors engage into data collection that is relevant for their sector. As the GIS mature, organisations discover specific applications of interest to them, and they collect data specific to those applications. In these stages, there is refinement in the information content that is collected from a national scale to application specific scale. The last stage of development is when there are a variety of Geographical Information services and information products available on the market. This is achieved when systems from different organisations are integrated and there are common portals for accessing information.

Figure 1. The benefit development process

7.3 A new model for GIS evaluation

The benefit accrual method considers two dimensions: the GIS developmental process and the benefit development process. Figure 1 illustrates how the benefit of improved availability of information evolves over time. The dimensions map particular benefits to a particular stage of development of the GIS. For the purposes of this model we consider the following benefits:

a) Improved Information Communication
b) Improved availability of data
c) Improved access to data

The mentioned benefits are chosen as they are accruing in the public sector of Uganda and yet there is no mechanism to measure them. These benefits are also mentioned in prior GIS literature as benefits accruing from use of GIS. The benefits are also non-financial which suit well the public sector organisations which are at times not profit oriented.

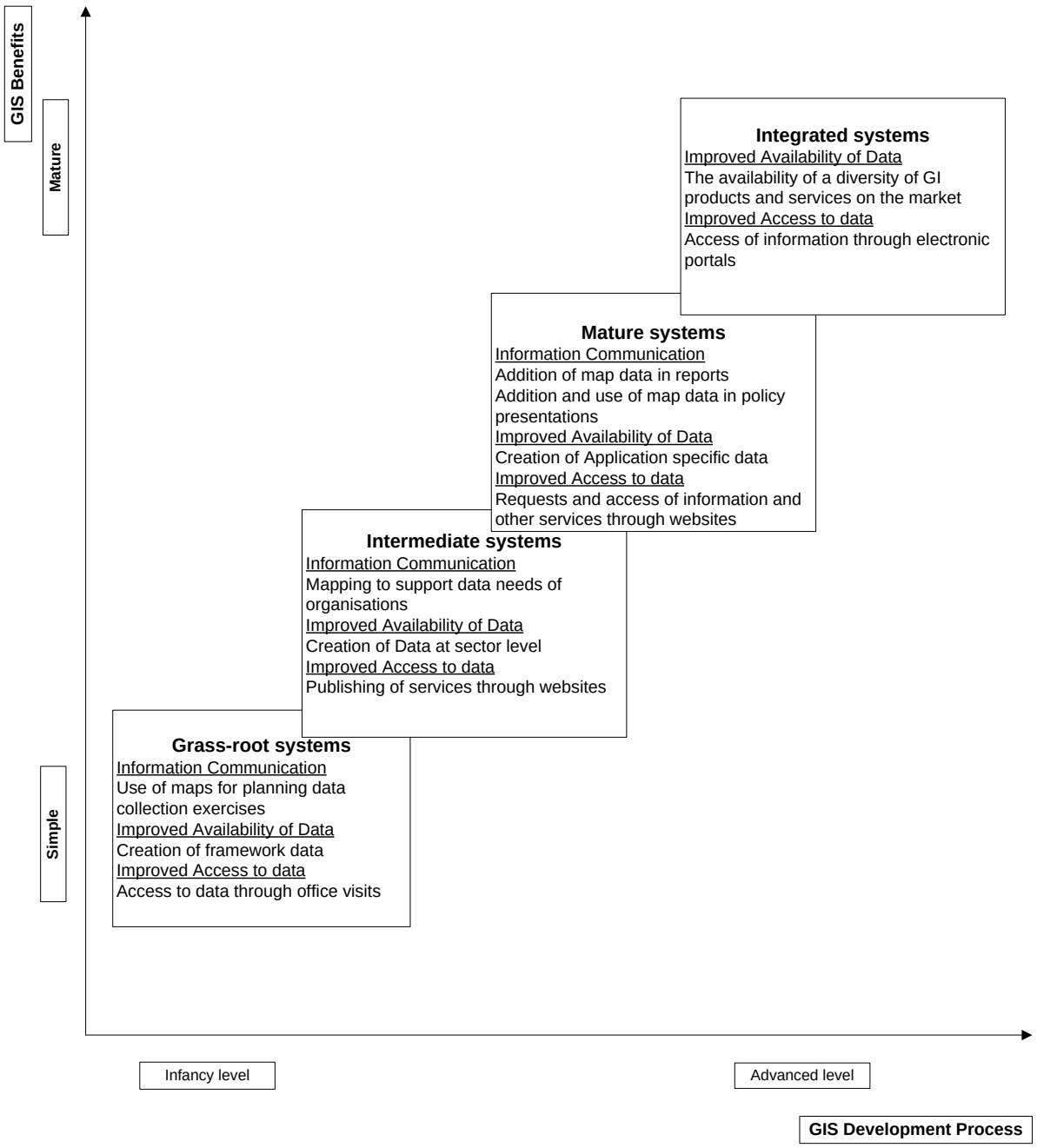


Figure 2. Proposed Model for GIS Evaluation

In Figure 2, the GIS develops from an infancy stage to an advanced level when it is fully mature. It does so by traversing through the grass-root, intermediate, mature and integrated stages. There are GIS benefits which are associated with each stage of development. A particular benefit can manifest itself in different ways depending on the level of development of GIS. An example is the improved access to data benefit which starts through access to data through office visits and then changes to publishing of services on websites. Thus as the stage of development changes, the benefits realised also evolve. As a result it is useful to compare systems at similar levels of implementation or at least those in consecutive developmental stages where benefits are expected to be almost similar

and the change smaller in magnitude. The development of GIS is affected by other factors such as staff trainings, software licence requirements and institutional arrangements existing in different organisations. These may offer practical problems when performing assessments based of systems implemented within the same period of time.

7.4 Applicability of model in different contexts

The linear development of GIS technology assumes that there are different stages which can be viewed in the implementation of GIS. An example that can be adapted is the diffusion of innovation theory. Each stage is associated with some specific benefits in the developmental process of GIS. Tulloch and Epstein (2002) suggest a situation in which benefits accrue incrementally from efficiency, effectiveness through to equity. As a result, comparing geographical information systems which are at different levels of implementation introduces practical difficulties because of heterogeneous benefits that accrue. At the same time, the practicality of having organisations displaying the same implementation characteristics may not be feasible. On the other hand, even for systems introduces in the same year, the organisational and institutional settings can influence the GIS development such that comparison will still be difficult. However, for the purposes of this method surveyed organisations should exhibit some form of *benefit level* as a checklist for inclusion in the sample. GIS at the same implementation should ideally have similar benefits accruing even though the extent of the benefits can be different for different organisations. For the sample, the ideal situation is to have organisations demonstrating similar implementation. Having the organisations being in the same sector such as health may increase the focus of comparisons as similar sectors present uniform goals and operations.

7.5 Evaluation providing performance feedback

The underlying question here is how do organisations compare evaluation results and with what. Should organisations compare the current with the initial evaluation when the system was implemented or with the last carried out evaluation? Overall, evaluation is also supposed to act as a feedback loop by continually giving information which not only future evaluations better but serve in comparing present with past situations. To detect minor changes it is better to compare subsequent evaluations, that is, the current evaluation with the one for the previous year assuming that evaluation is carried out as an annual activity. It is also useful to compare with the initial evaluation for the systems or some past evaluations to determine how the benefits develop, evolve and possibly accrue over time. At the same time some changes may not manifest within year but maybe in two year segments. At the same time, some benefits take longer periods to fully develop for example, democratisation. Democratisation (Sawicki and Craig 1996) commences with increased information access channels until the use of the information diffuses such that there is equity in accessing information. At the last level, there is empowerment through equal access to public domain information.

7.6 Frequency of Evaluation

Evaluation can be carried out annually at the end of the year like any other financial audit being carried out in the organisation. This way the information from previous evaluations can feed into new evaluations which can improve the assessment by also comparing with previous situations. If evaluations can be done annually then they also become routine in judging GIS success or lack of success of the systems. As a result, the GIS will end up being aligned to the strategic objectives of the organisation once the problem areas are addressed. A single annual evaluation takes into account the time and financial constraints presented as evaluation constraints in the surveyed organisations. A more feasible approach is to have a time allocation for evaluation within organisations with evaluation approached from a point of view where the strategic value of having the GIS is revealed.

7.7 The ideal situation for benefit accrual

Gillespie (1994: 63) argues that "the key to measuring benefits is to identify what has changed because of the GIS." As a result, I argue that a benefit accrues when some positive change occurs from use of the GIS which is the essence for identifying benefits for the proposed method. From this point of view, there is a difference from a status of having and not having a benefit. This presents a yes or no issue though of interest, is also to determine the extent of the benefit. There is need to know whether the benefit is minimal, moderate or high or to use some other scale for quantification. The descriptions of a benefit based on some given scale are particularly useful when the benefits also change over time. Table 6 illustrates some of the ideal situations in which the benefits accrue through the expected outcome and the decision criteria. The parameters significant to a benefit oriented approach for evaluation are also presented. This includes possible outcomes and decision criteria which are useful in measuring the benefit. Any other benefit can be added to the framework by following the procedure. However, there is still need for the appropriate quantification and the tools to employ when carrying out the evaluation.

Table 6: A benefit oriented evaluation approach

Intangible Benefit	**Expected Outcome**	**Decision criteria**
Improved communication and reporting of information	Use of maps in reports	If GIS maps are increasingly used in reports and publications then improved reporting is realised
	Use of GIS maps in policy briefings	The use of GIS visualisations to support other documentation in policy briefing amounts to improved communication.
Improved availability of data	Faster production of maps and other information products	If data can be accessed on demand then there is improved availability.
Improved access to data	Dissemination of data through multiple service channels	The existence of multiple service channels which work in accessing data constitutes improved access.
Improved policy formulation	Effective policy interventions	If policy makers are more informed they need less time in formulating policy
Improved service delivery	Faster response to client needs	If the time for handling requests has reduced then queries are handled faster
	Creation of new services	Services are new when they could not be produced before GIS implementation.

8. Conclusion

There have been several efforts to assess GIS tangible benefits that are closely related to costs or income as presented in (Gillespie, 1994; Tulloch and Epstein, 2002). However, less effort has been put on intangible benefits particularly with a bearing on society. Sheppard (1995) discusses the role GIS play in the societal settings they are implemented and their need to serve the public.

The aim of this study was to learn from other implementations in the context of Uganda public sector so that organisations with grass root systems could improve on the implementation and adoption process. Through learning and understanding current problems and successes, it would then be possible to provide a tailor made solution for public sector GIS evaluation for Uganda as stipulated below.

The proposed method stipulates the stages of the developmental process in which GIS benefits accrue. These manifest as grass-root, intermediate, mature and integrated systems. The benefits also evolve or develop with each developmental stage of the GIS. The proposed method uses information communication, improved availability of data and improved access to data as the benefits that evolve over time. The purpose of the method is to identify the benefits within a particular point in time or to identify the developmental stage of the system basing on the benefits accruing. The actual measurement of the benefits is not fully explored in this research. The linear model of benefit accrual is only a best fit as there is always noise and other factors during the development process. Further development of this model is recommended by focusing on the tools of measurement and physical testing in an organisational setting. This study has covered *what to evaluate* and how to identify the benefit to be evaluated. The new method provides a basic framework which is usable in different cases by addressing some of the practical difficulties which are faced in evaluation in practice.

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